

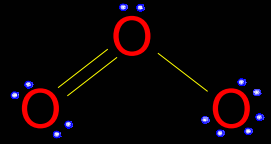
# Process Control Oxidation

Walt Disney World Life Support

Chemistry Department

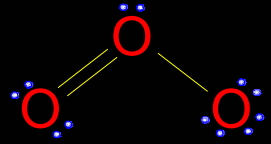
Kristen S. Mertens

# Agenda

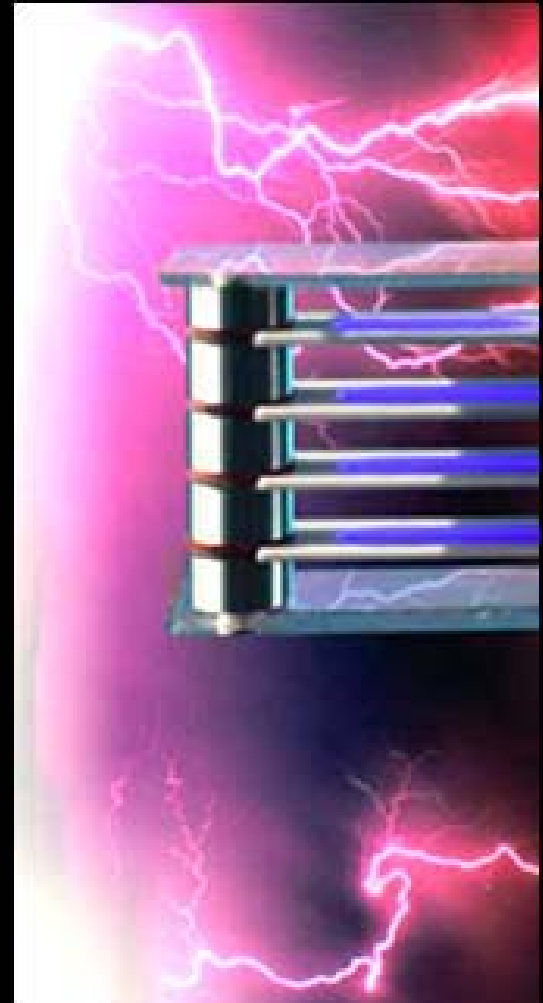


- Ozone Overview
- The Seas Overview
- Process-Controlled Oxidation

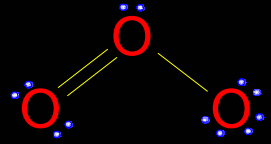
# Ozone Benefits



- Powerful
- No trihalomethanes
- Short contact time
- Microflocculation on contact
- Decays to oxygen



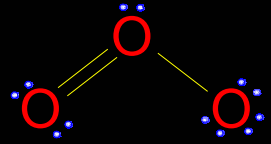
# Ozone Challenges



- Hazardous disinfection byproducts
- Technologically advanced
- Unstable
- Potentially toxic

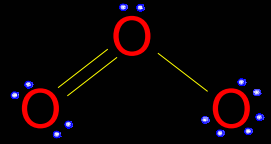


# Agenda



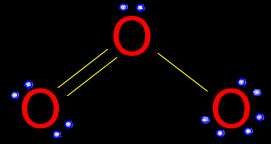
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# Seas Basics



- Over 20 years old
- 6.7 million gallons
- 3 hour turnover
- 2 isolation tanks

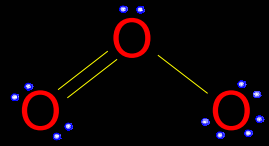
# Seas Basics



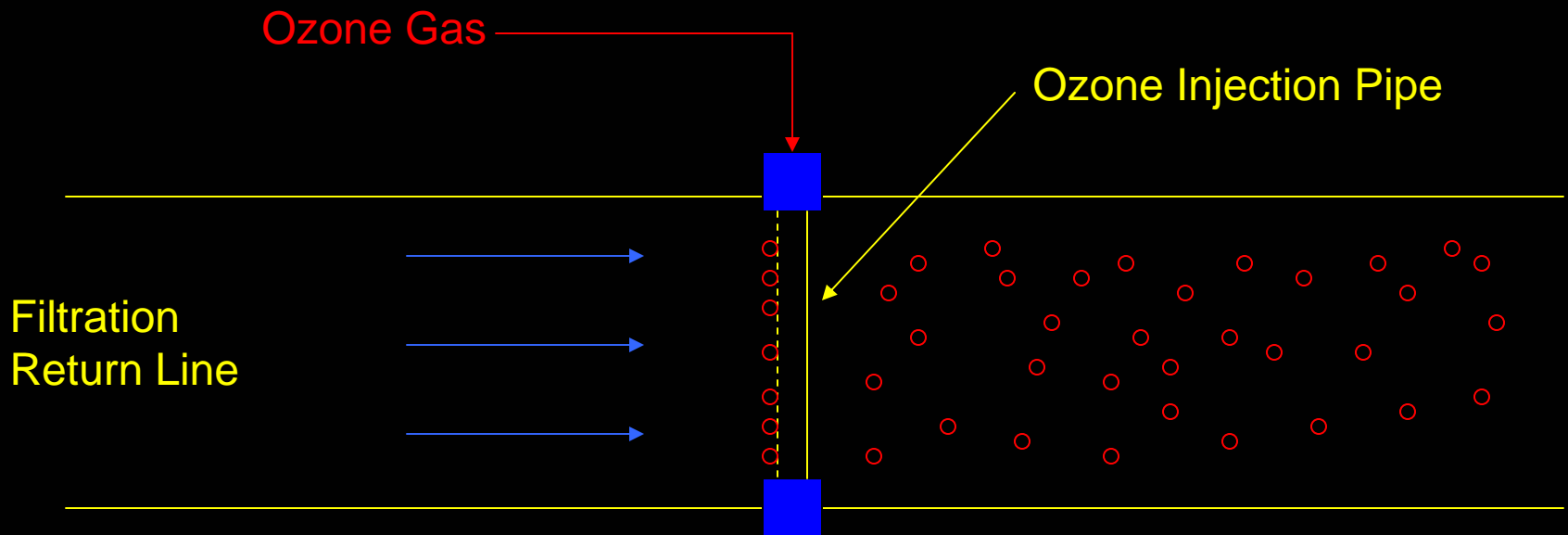
- Sand and carbon filters
- Ozone with aeration
- Denitrification
- Water reclamation



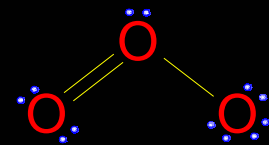
# Seas Ozone History



- Originally full-stream ozone injection
- Generators delivered  $\sim 2\%$   $\text{wt.}/\text{vol}$  O<sub>3</sub>

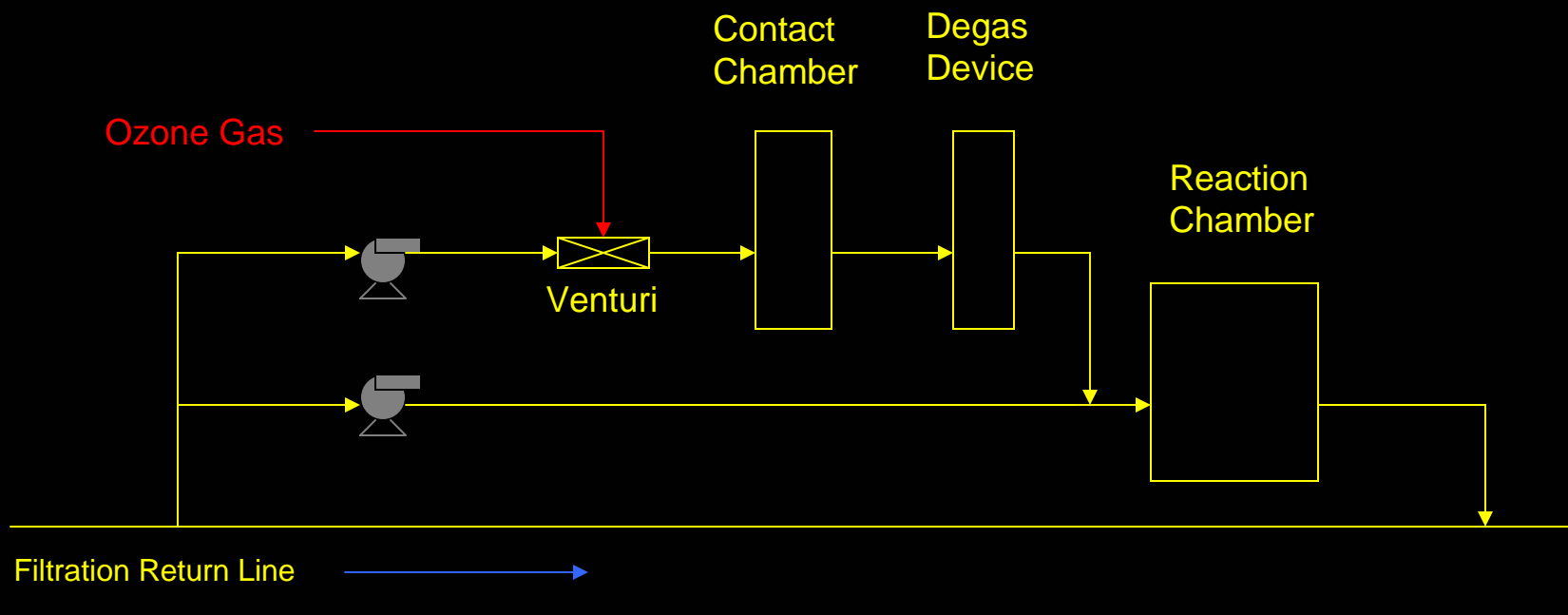




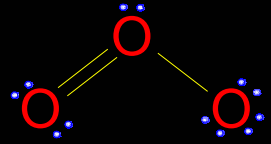


# Seas Ozone History

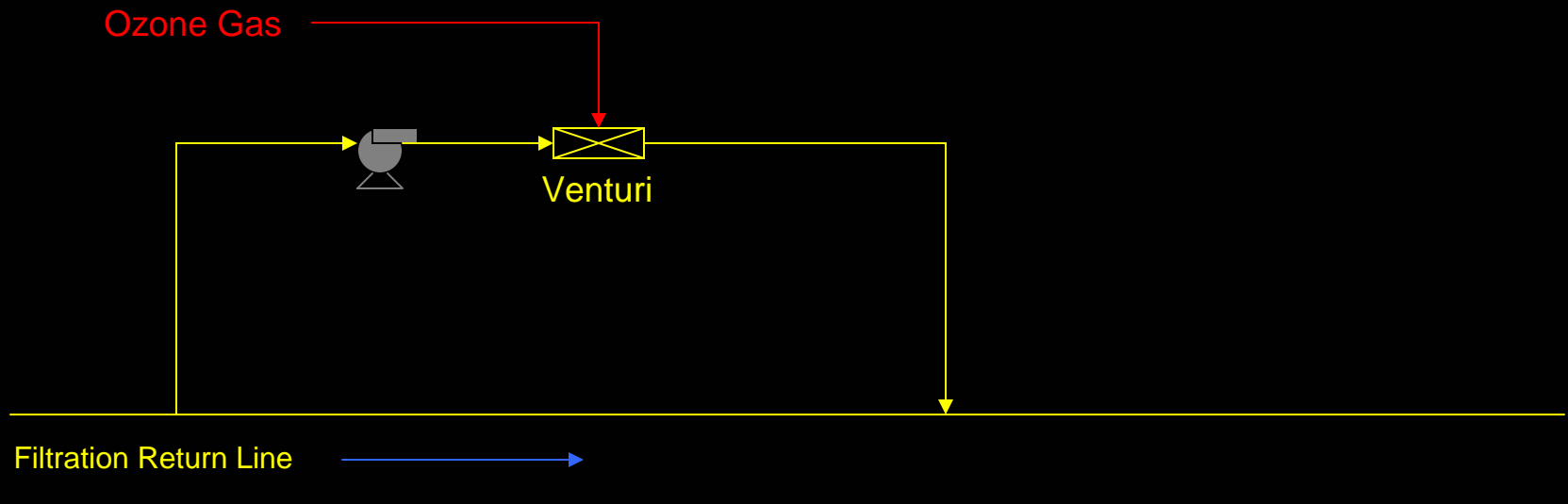
- 1997 modified to Side-stream
- Flow rate 12-13% of total flow rate



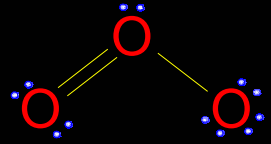
# Current Seas Ozone



- 2002 modified to direct injection with venturi
- High mass transfer efficiency >98%

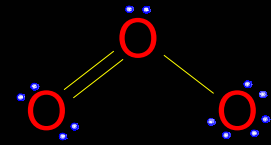


# Agenda

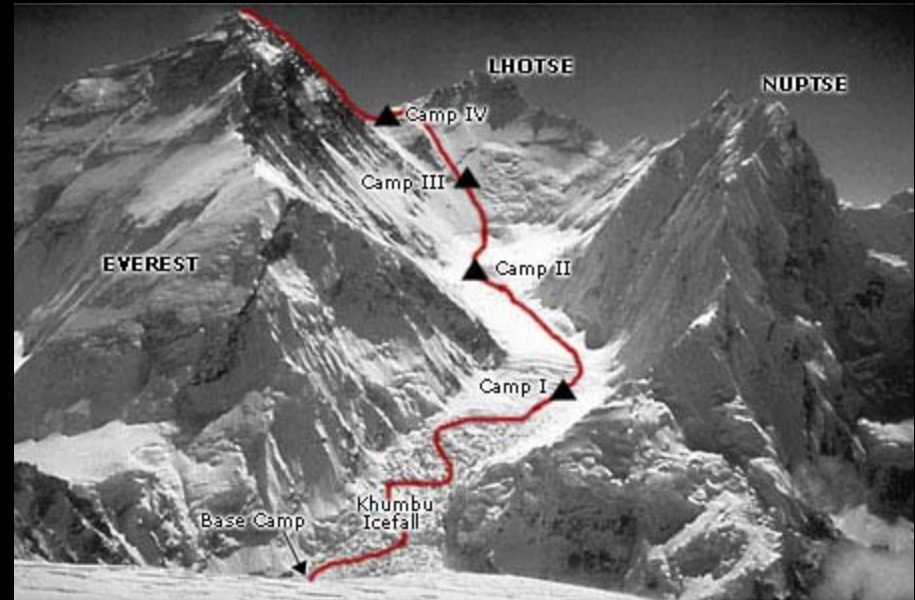


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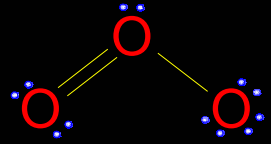
# Process-Controlled Oxidation Goals



- *Safe*
- Feedback monitoring
- Ozone quenching
- High ORP post-contact
- 24/7 runtime
- Reliable

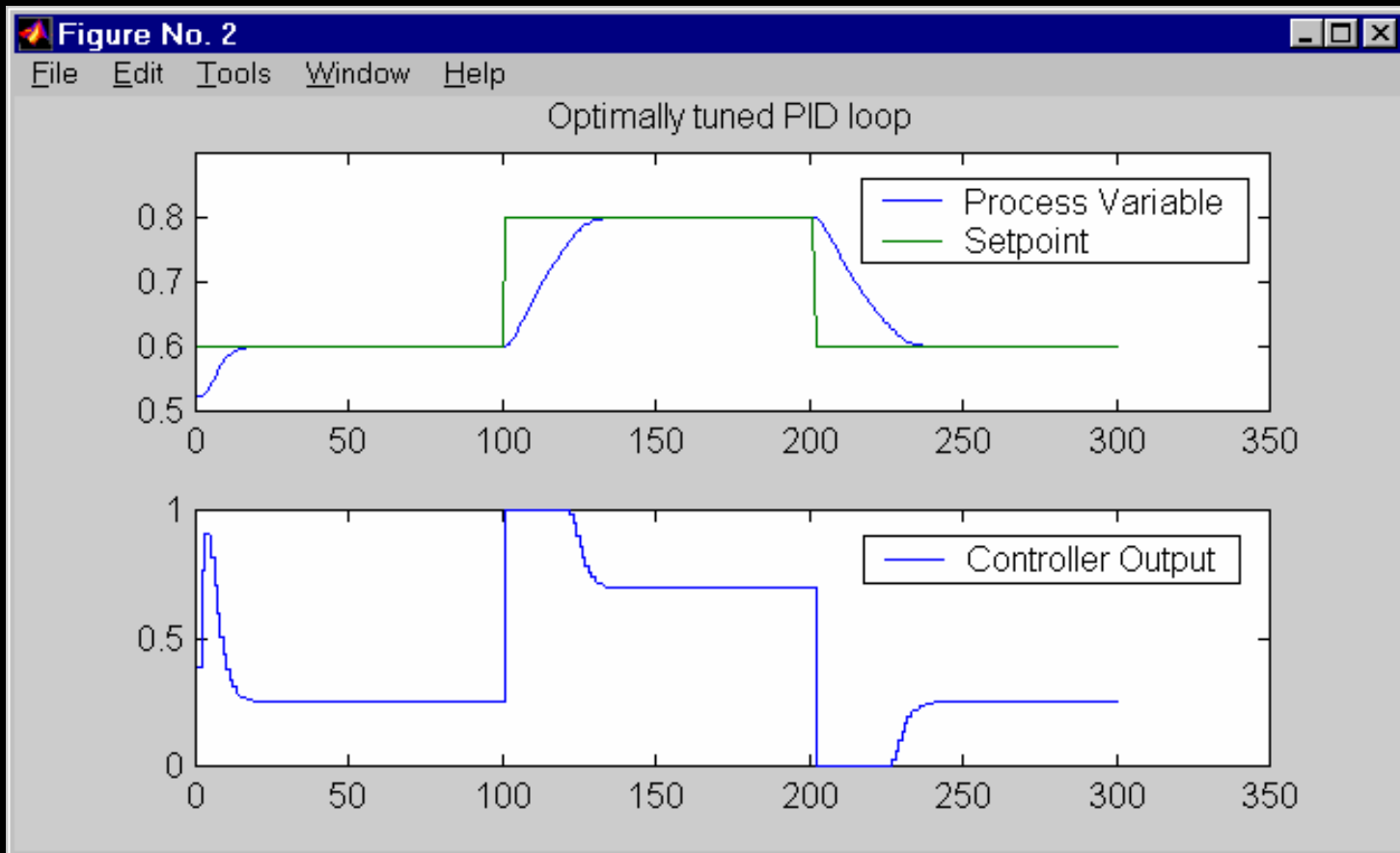
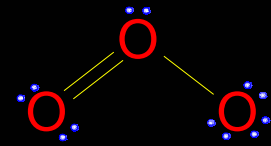


# PCO Safety

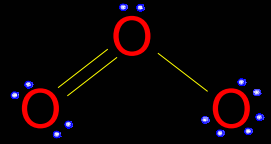


- Multiple control parameters
- Operator page-out notifications
- Automatic shut-downs
- Redundant measurements

# Proportional Integral Derivatives



# Required Components



- Well-trained staff
- Side-stream ozone injection
- ORP monitoring
- Ozone-residual quenching
- Control computer

# Main Line Ozone Control

ORP  
MT Skimmer

231.44

ATE West  
Output 6.35

569.08

Injection Auto

ATE East  
Output 5.11

568.40

ATE East and West Setpoint 580.000

M1, M2, M3

Turn OFF  
Main Line  
Ozone  
System

OZONIA

25.38 %

OZONIA

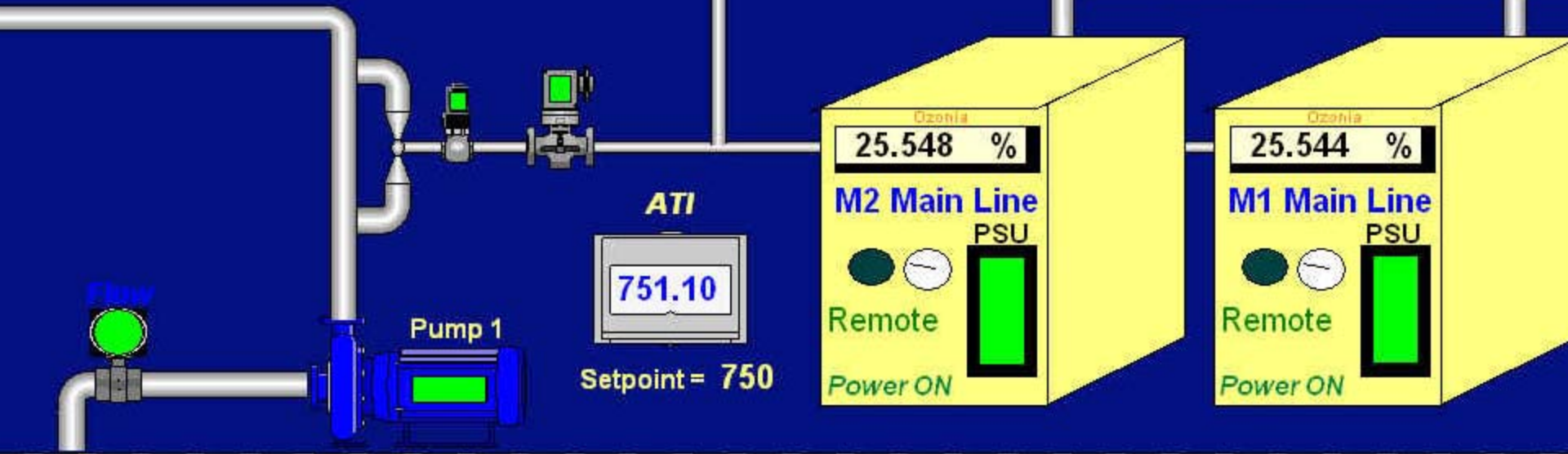
PSU

Remote

M3 Main Line

Power ON

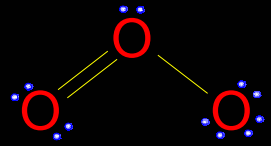
M1 M2 Cooling Water Temperature = 15.8 de



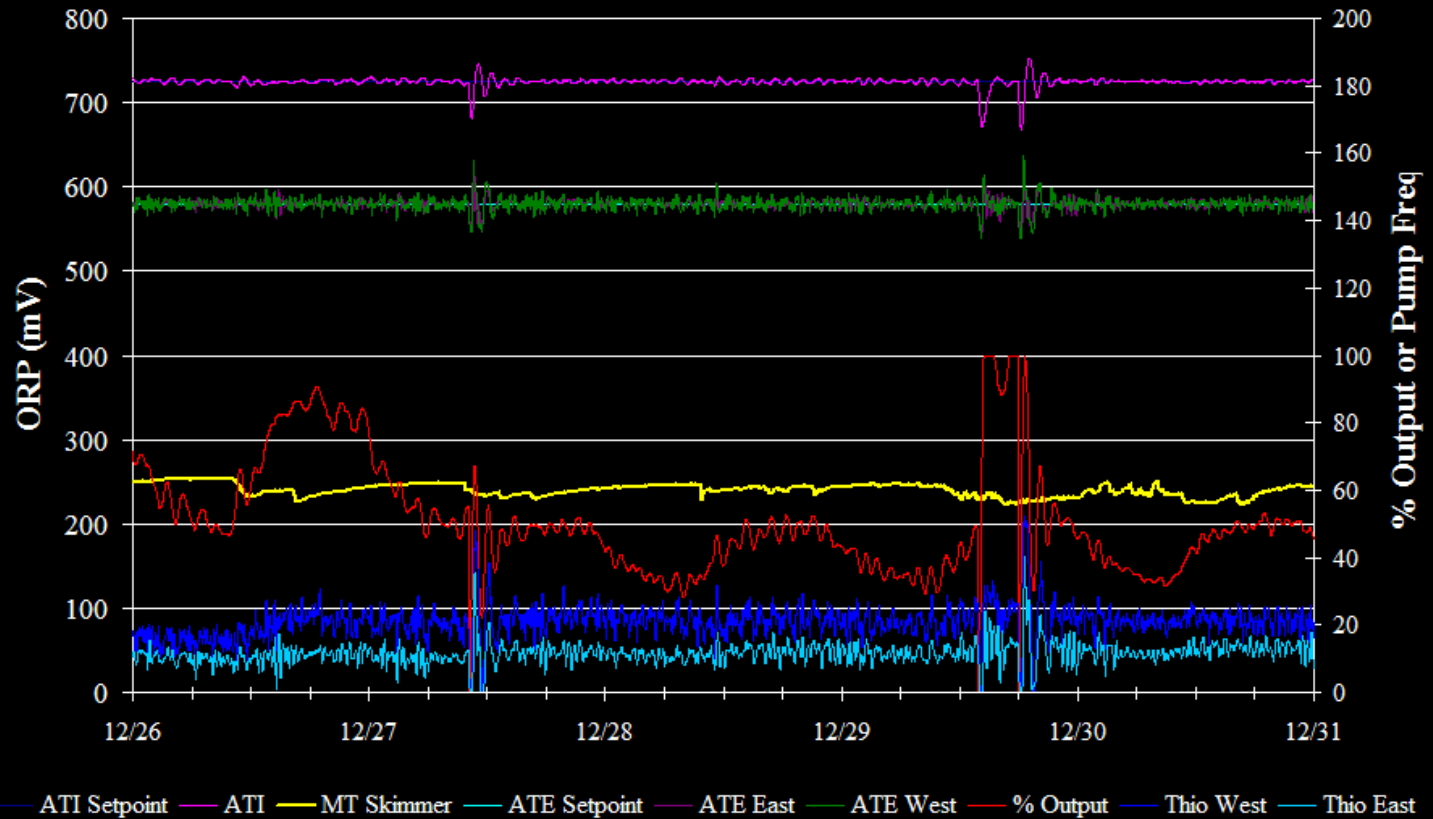
EXIT



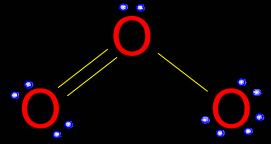
# Data Logging



## Main System ORP Tracking



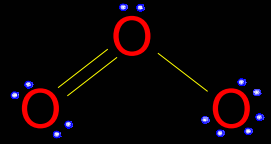
# Does it work?



- Water clarity improved
- Remediation of algae
- Enhanced disinfection

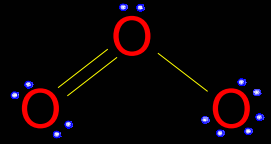
# Yes!

# Agenda



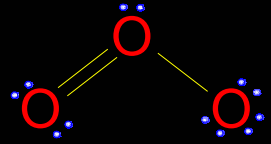
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# Awards



- The “Process Controlled Oxidation” process was submitted for award of patent in 2005.

# Thanks and Acknowledgements



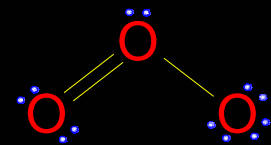
Ivey Burns

Thoram Charanda

Richard Davis

Tom Nicodemo

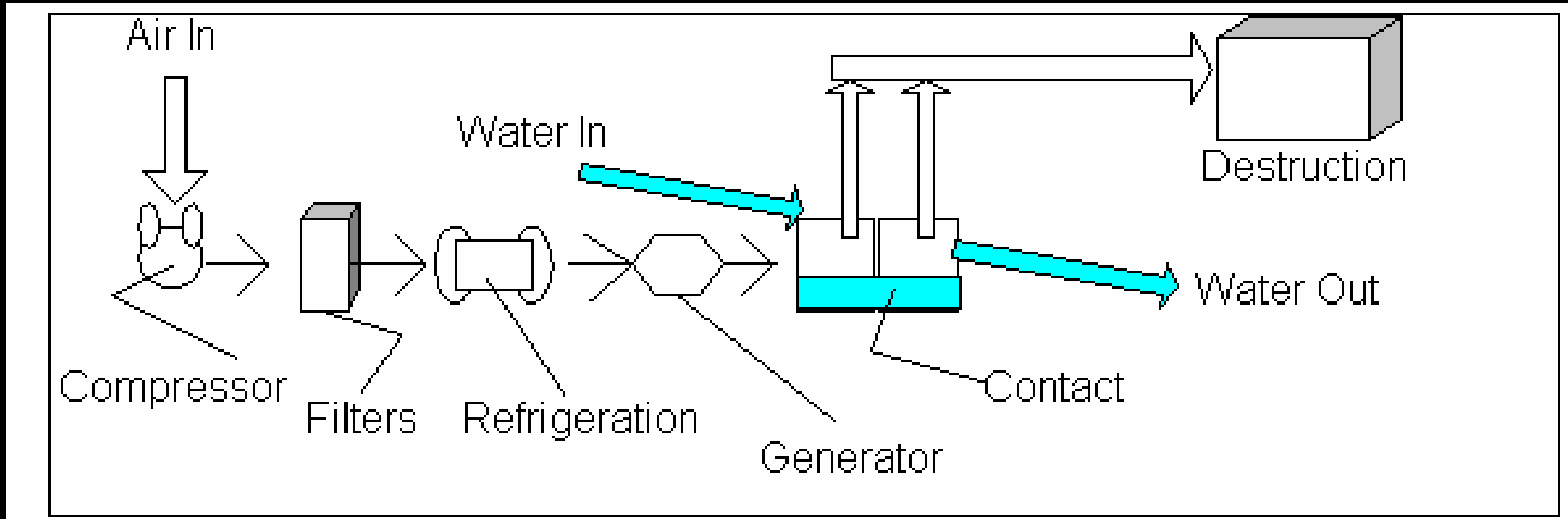
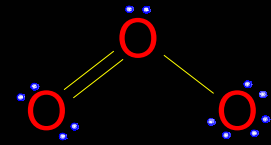
Lonnie Lamb



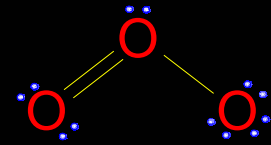
“Sea” you  
real soon!



# Air Prep System



# Nernst Equation



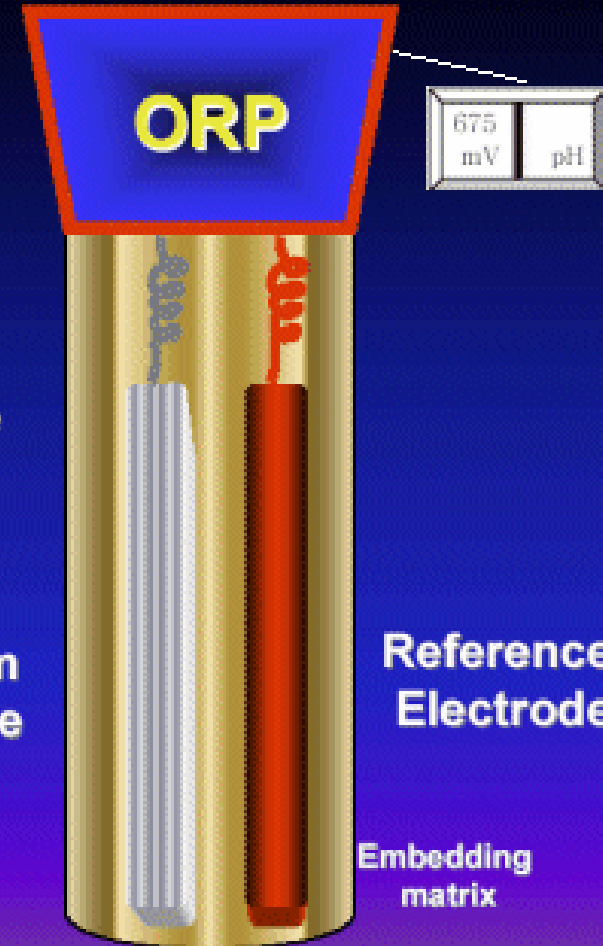
$$E = E_0 - \left( \frac{RT}{zF} \right) \ln \left( \frac{a_{red}}{a_{ox}} \right)$$

Strong Oxidizers pull electrons away from platinum probe creating a small voltage differential to the reference probe.

Platinum Electrode

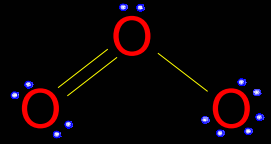
Reference Electrode

Embedding matrix





# Approximate Costs



Approximate Cost	
Dosing pumps	\$1,000
Thio tank	\$500
ORP probes (ea) minimum 2	\$600
Control computer	\$3000-\$5000
Installation	\$5000-\$10,000